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file SWYTAF

THE STATE OF WYOMING

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MEMO

TO: **SWYTAF Technical Committee**

(Terry Svalberg, Susan Caplan, Kevin Golden, Lee Gribovicz, Bernie Dailey, Dan Olson, Dolly Potter, Dan Heilig, Tamara Blett, Otto Schnauber, Baptiste Weed, Doug Blewitt)

FROM: Darla Potter

SUBJECT: Technical Memorandum on Episodic Model Runs

DATE: January 19, 1999

On January 19, 1999 the Division received a technical memorandum from Earth Tech documenting the "Hourly Concentration Plots for a Summer Episode Day and a Winter Episode Day in the SWYTAF Domain." The Division is providing you with a copy of the technical memorandum text and the plots referenced in the text.

Only the referenced plots are being provided to you at this time as the document is 2 inches thick. For each episode, plots for each hour of the day for each pollutant (SO2, SO4, NO, NO2, HNO3, NO3, PM2.5, BIO-SOA) were provided. Should you have the desire to review all 2 inches, please let me know and I will make a copy available for you.

TECHNICAL MEMORANDUM
Hourly Concentration Plots for a Summer Episode Day and a Winter Episode Day in the SWWYTAF Domain

Earth Tech, Inc.
January 1999

Two sensitivity simulations have been conducted with CALPUFF in which hourly concentrations of the major species (SO_2, SO_4, NO, NO_2, HNO_3, NO_3, $PM_{2.5}$, and SOA) have been computed over the entire CALPUFF computational domain. In most of the previous runs of CALPUFF, receptors were located only in the Class I areas of concern in this study (the Bridger Wilderness Area and the Fitzpatrick Wilderness Area). In this memo, the results for a summer episode day (July 12, 1995) and a winter episode day (December 26, 1995) are presented over the entire modeling domain. These days were selected because relatively high extinction coefficients were predicted in the Class I areas on these days in the preliminary CALPUFF simulations.

The sampling grid (gridded receptor) option in CALPUFF was selected. This produced 11,600 receptors at the 116 x 100 meteorological grid points. The receptor spacing is 4 km. The receptors are located at the local ground surface. The terrain elevation of each gridded receptor is based on the 4 km averaged gridded terrain heights used in the meteorological model (i.e., derived from the GEO.DAT file).

The two simulations were "cold starts", meaning the modeling domain started with clean conditions. As a result, the effect of the start-up conditions can be seen in the first few hours of the simulations. The hourly concentrations of each species are presented in the attached plots. A standard set of concentration isopleth levels were used in all the plots.

The purpose of this analysis is *not* to make generalized conclusions regarding source contributions to impacts in the Class I areas. Only two days of modeling results were analyzed. Instead, the purpose is to evaluate the reasonableness of the concentration patterns produced by the model based on the emission inventory used and the chemistry involved.

July 12, 1995 Episode Day

The SO_2 concentration plots show the strong effects of terrain on the flow fields and the resulting concentration footprints. The largest impacts are associated with the major point sources and CEM sources (see Figure 2-3 in Volume I of the emissions reports). The sources in the Salt Lake City area and Pocatello area are transported primarily to the north and for the most part do not pass over the mountains into Wyoming during this episode. Different advection is indicated for sources located in the valley in the Salt Lake City area versus those located to the east in the higher terrain areas. There is some deflection westward of the plumes from certain sources in SW Wyoming into Idaho (see SO_2 plots for Hours 20-23). This patterns seems reasonable given the high terrain just north of the sources near the Idaho-Wyoming border (see Figure 2-3 in Volume I). Other sources located slightly to the east are deflected to eastward around the terrain features. The highest impacts in the Bridger Class I area are during the late morning and afternoon hours (Hours 10-16). Several of the plumes show significant curvature to the trajectories, as the puffs respond to changes to the local wind flow. This is especially apparent in the evening hours (after Hour 20) when Froude number effects (terrain blocking) become important.

The sulfate pattern is strongly correlated with the SO_2 plumes, as expected based on the chemistry. Most of the sulfate production occurs during the daytime hours, which is also an expected result based on the higher daytime SO_2 to SO_4 conversion rates. NO exhibits a different pattern. The NO plumes are more localized and patchy. They tend not to extend downwind in long plumes from individual sources as much as SO_2. This is due to its relatively rapid conversion to NO_2. A number of different sources are evident in the NO plots that do not show up in the SO_2 fields, which seems reasonable based on the emissions distribution (see Figure 3-1 of Volume I). Regionally, most of the NO_x appears as NO_2. A long plume extends from the Salt Lake City area northward into Idaho. Plumes from the sources in SW Wyoming are deflected in a "Y" pattern around the central part of the Bridger WA during this day (e.g., see the NO_2 plot for Hour 11), with plumes moving to the NW and then NE around the northern part of the WA, and to the NE and then the N around the southern part of the WA. Note that there are some channeling effects moving pollutants into the southern part of the Grand Teton National Park (e.g., see the NO_2 plot for Hour 17). It is evident that the wind patterns are quite complex and variable, and that straight-line plume models such as ISC are not likely to be effective in this domain over these scales.

The nitric acid (HNO_3) and nitrate (NO_3) patterns are consistent with their status as secondary pollutants generated from NO_x. The highest concentrations are displaced further downwind from the sources, reflecting the delay in formation of these pollutants as a result of chemical reactions. The highest values are predicted during the daytime, consistent with the more rapid chemical conversion of NO_x into HNO_3/NO_3.

The $PM_{2.5}$ pattern is like the NO pattern in that there are many "hot spots" resulting from local emissions. The $PM_{2.5}$ concentrations shown are for primary fine particular matter only, not secondary $PM_{2.5}$ such as SO_4, NO_3, and SOA. The large area sources (county emissions) are evident. Also apparent in the modeling results is the difficulty for emissions to cross the mountains along the Wyoming - Idaho/Utah border during this 24-hour event.

The biogenic SOA patterns are quite different from the anthropogenically-derived pollutants. The patterns are generally localized and small-scale. The biogenic VOC emissions are emitted in largest amounts from the forested areas (see Figure 7-2 in Volume I of the emissions report), and often in the high terrain areas. This produces many "hot spots", and the direction of the advected SOA plumes reflect the high terrain release locations. SOA concentrations are low in the urban areas. There are a number of high impacts in the Bridger and Fitzpatrick WAs apparently resulting from local biogenic emissions. The SOA concentration patterns appear to be consistent with the distribution of biogenic emissions and the chemical processes involved. Contour plots of anthropogenic-derived SOA were also produced, but they are not presented because the concentrations did not reach the lowest contour interval (0.2 $\mu g/m^3$) used in the plotting. This is expected based on the small fraction of total $>C_6$ VOCs due to anthropogenic sources.

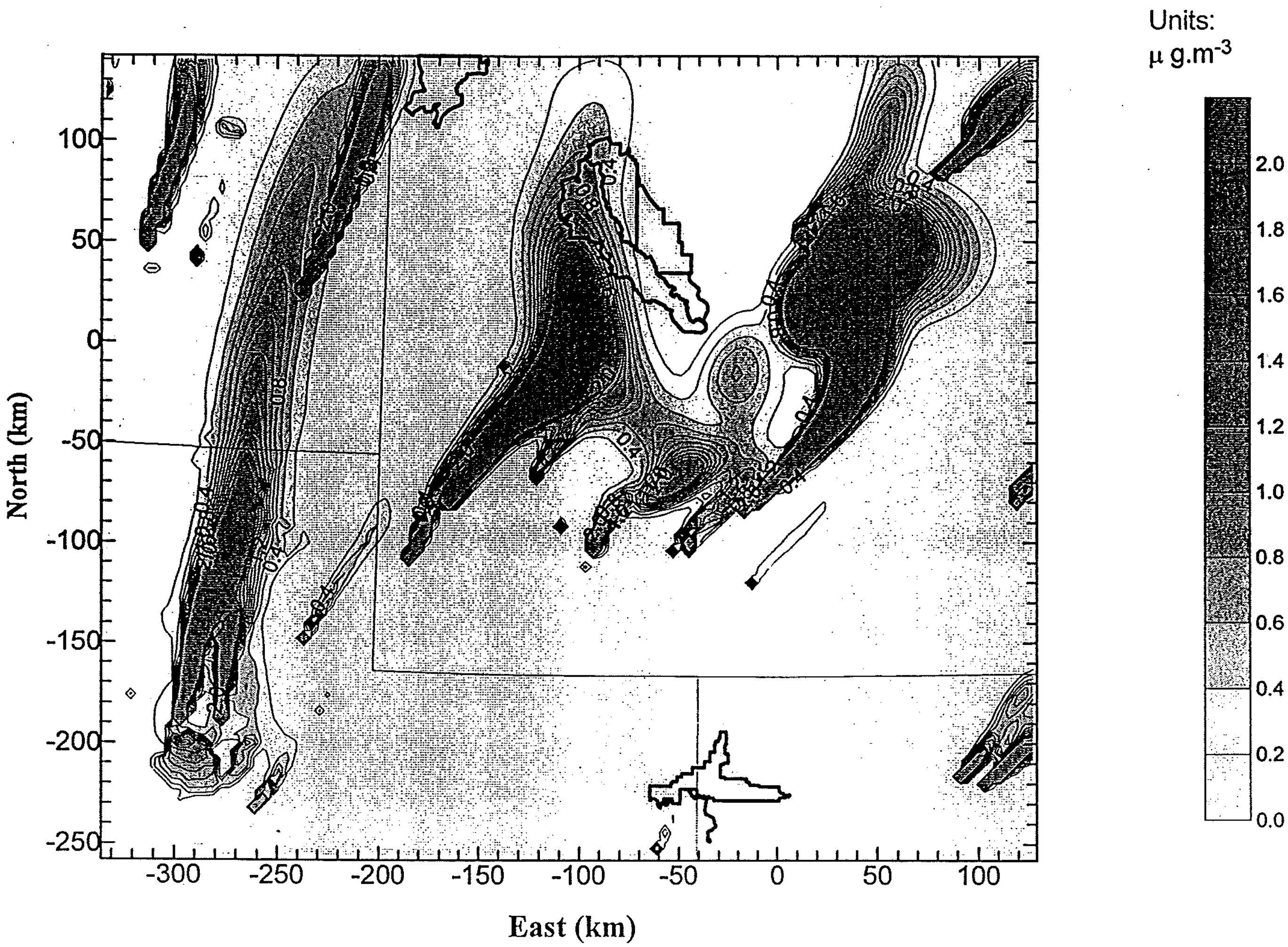
December 26, 1995

The trajectories of the SO_2 plumes in this event show much variability over the domain, with S-N flow in Utah and Wyoming, W-E flow in southern Wyoming, and NW-SE and N-S flow over NW Colorado and southern-central Wyoming. To the east of the Class I areas the flow is weak and stagnant. One interesting feature of this day is the transport of SO_2 westward from sources in the Riverton area into the Class I area (see the SO_2 plots for Hours 18-19). The SO_4 patterns are extended in broad areas displaced downwind from the SO_2 sources, likely caused by the slower chemical transformation rates than in the summer episode. The sulfate impacts in the WA area are due to the westward transport from SO_2 sources to the east.

The NO_2 footprint wraps around the Class I area to the SW of Bridger, moving SE and then E. There is impact in the Grand Teton NP of NO_2 from sources near Jackson. There is very little HNO_3, reflecting its temperature dependence (formation of NO_3 is preferred at lower temperatures). More NO_3 is produced in the winter episode, especially in southern Wyoming and in Utah. The seasonal differences in HNO_3 and NO_3 concentrations seem reasonable qualitatively. Primary $PM_{2.5}$ concentrations are larger in the winter episode, possibly due to increased emissions (e.g., wood burning) and less dilution (e.g., lower mixing height, more stable conditions). The SOA formation is reduced, due to lower emission rates in the winter.

SO2 CONCENTRATION IN SWWYTAF AREA

10 hr July 12, 1995



Class 1 Areas

Parks

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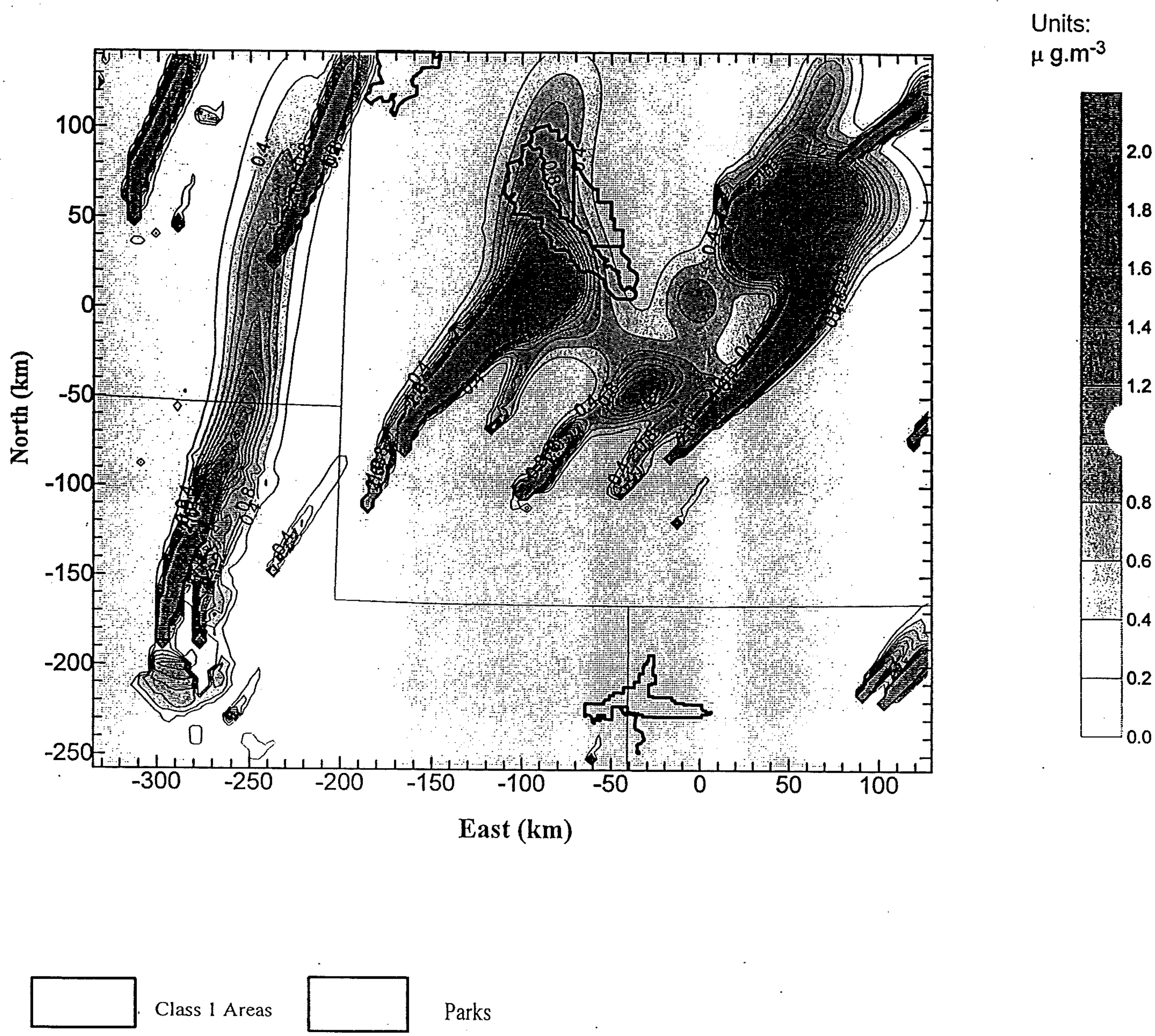
SO2 CONCENTRATION IN SWWYTAF AREA

11 hr July 12, 1995



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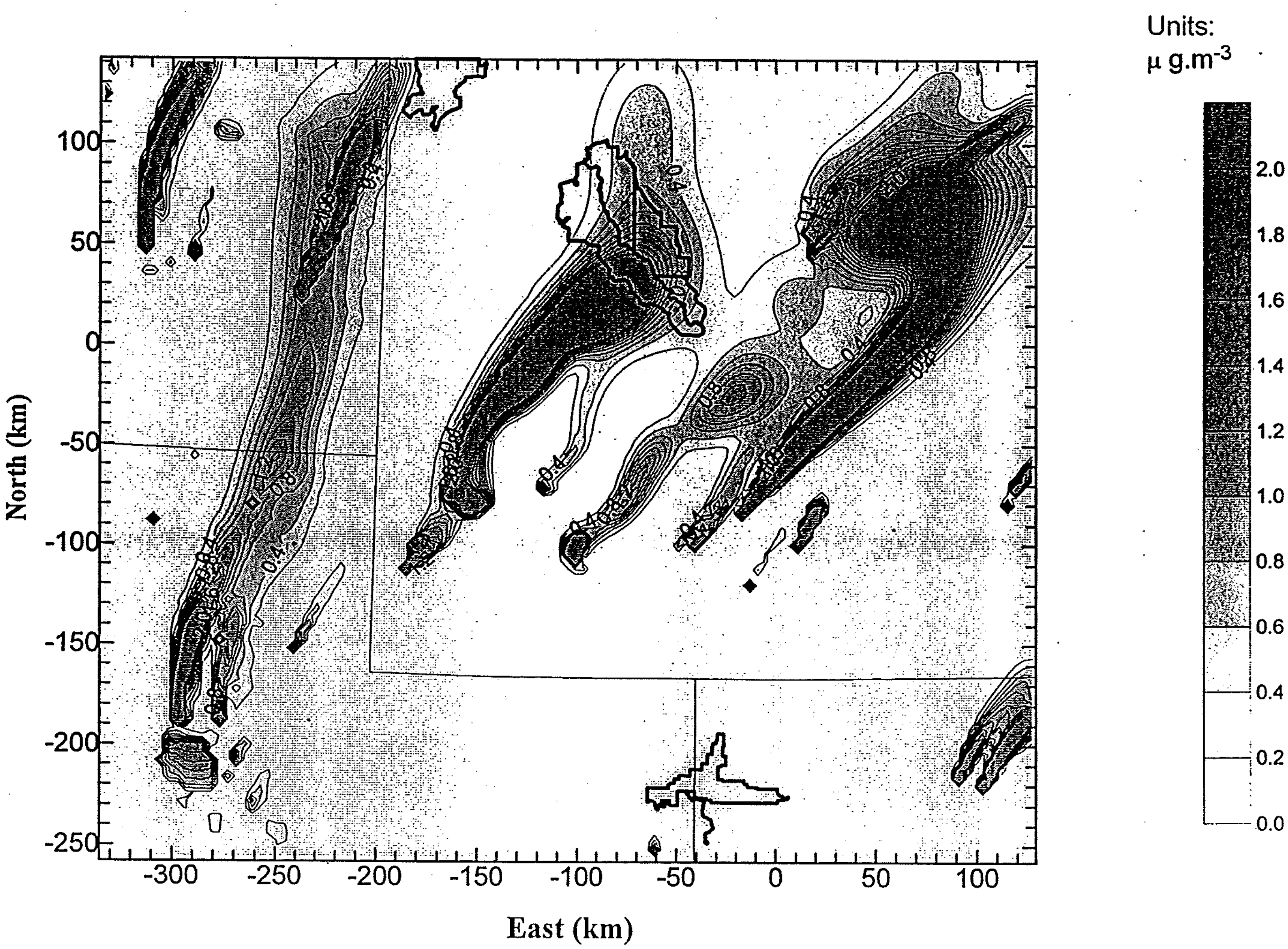
SO2 CONCENTRATION IN SWWYTAF AREA

12 hr July 12, 1995



Class 1 Areas

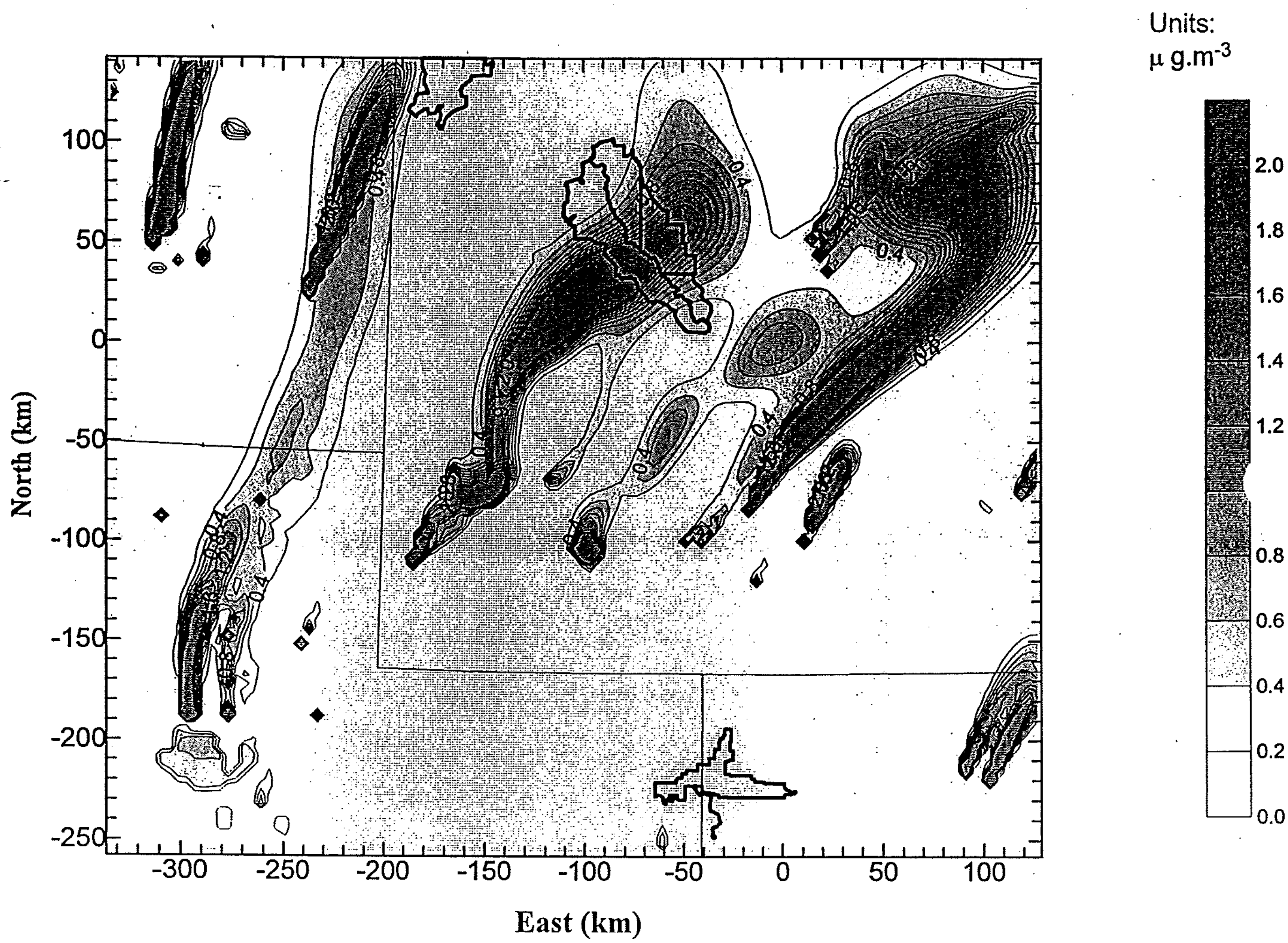
Parks

e:/projects/swwytaf/9901/1930112SO2.srf

SOLVAY2016_1.4_001819

SO2 CONCENTRATION IN SWWYTAF AREA

13 hr July 12, 1995



Class 1 Areas

Parks

c:/projects/swwytaf/9901/1930113SO2.srf

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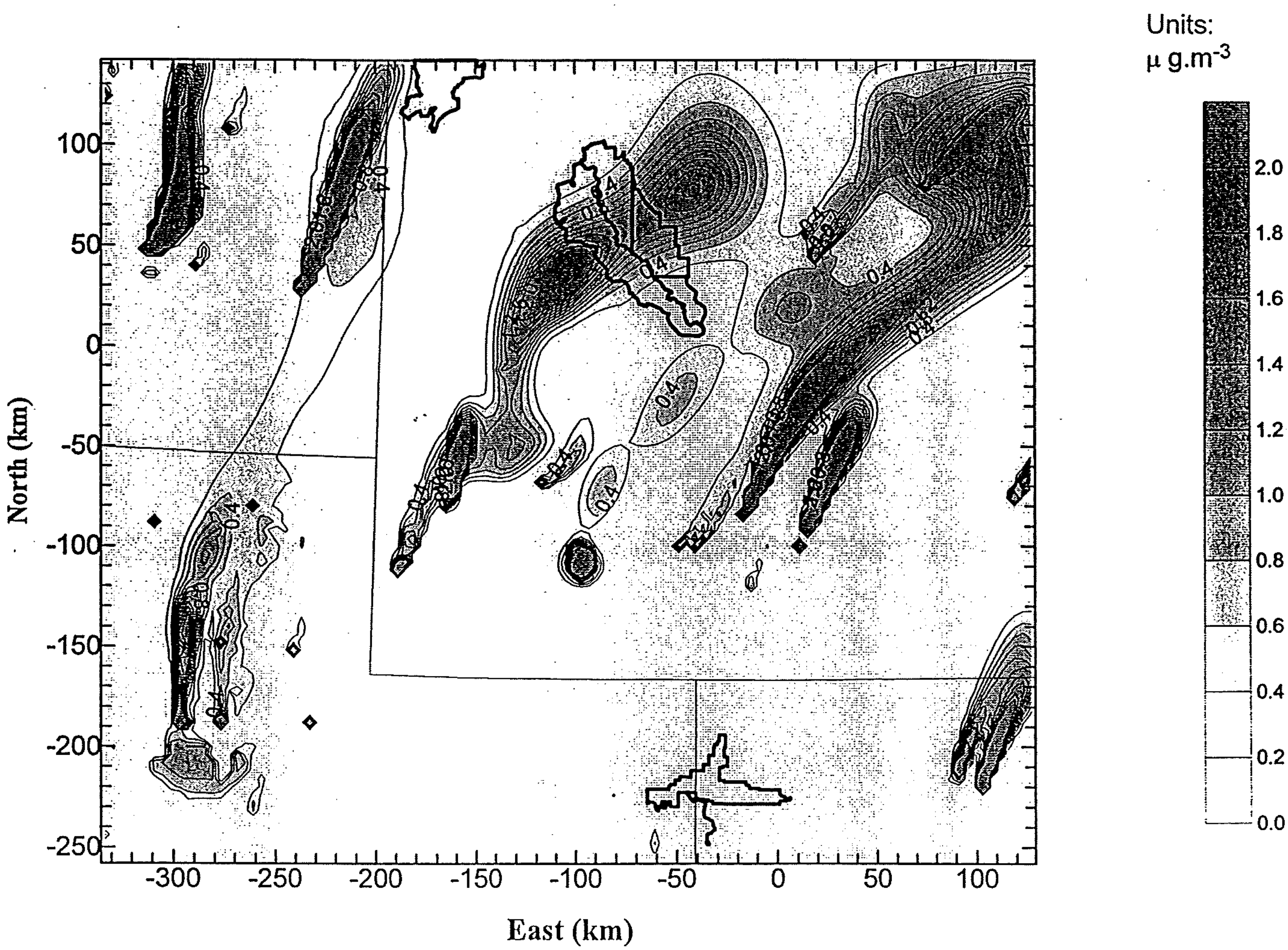
SO2 CONCENTRATION IN SWWYTAF AREA

14 hr July 12, 1995



Class 1 Areas

Parks

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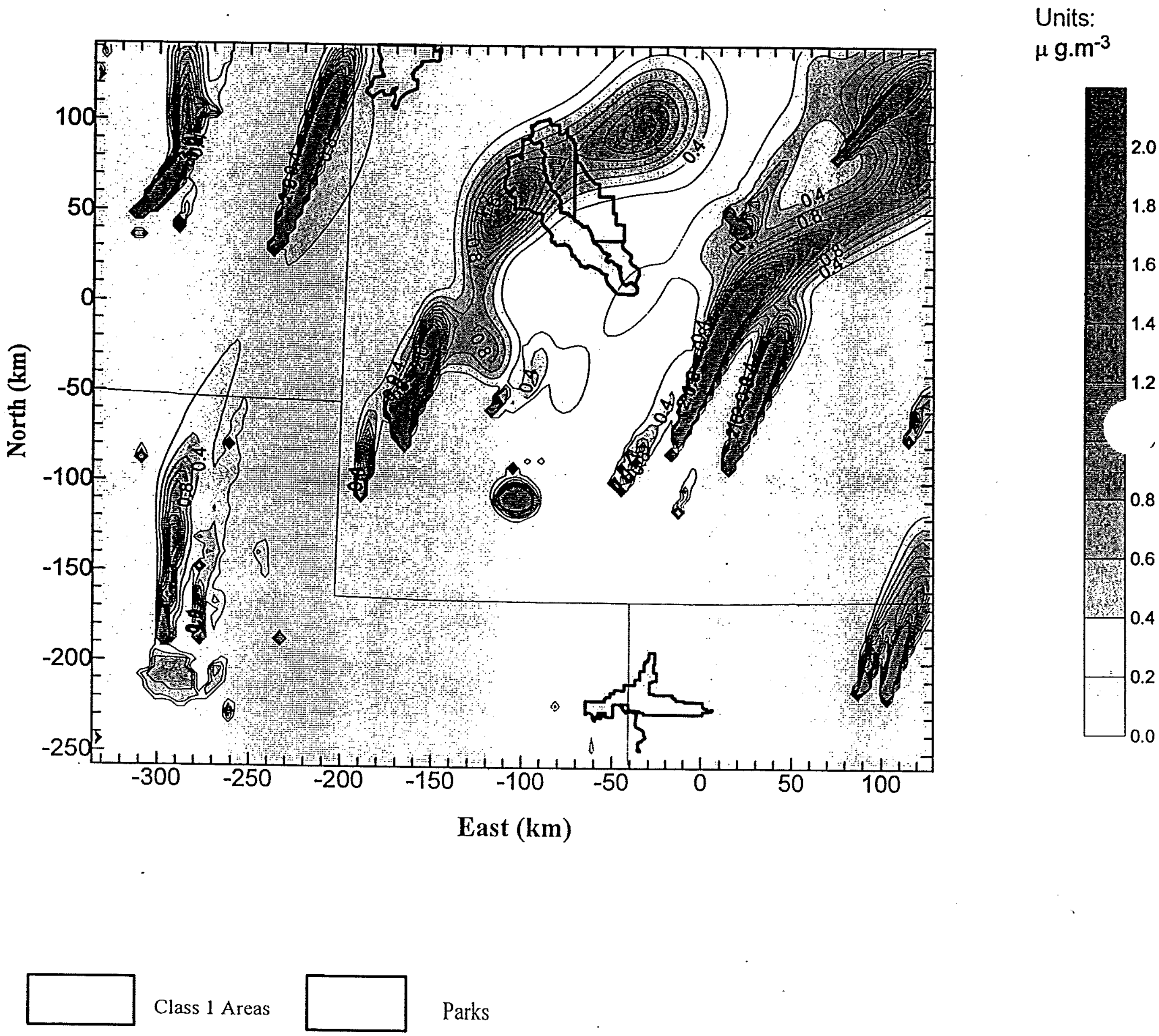
SO2 CONCENTRATION IN SWWYTAF AREA

15 hr July 12, 1995



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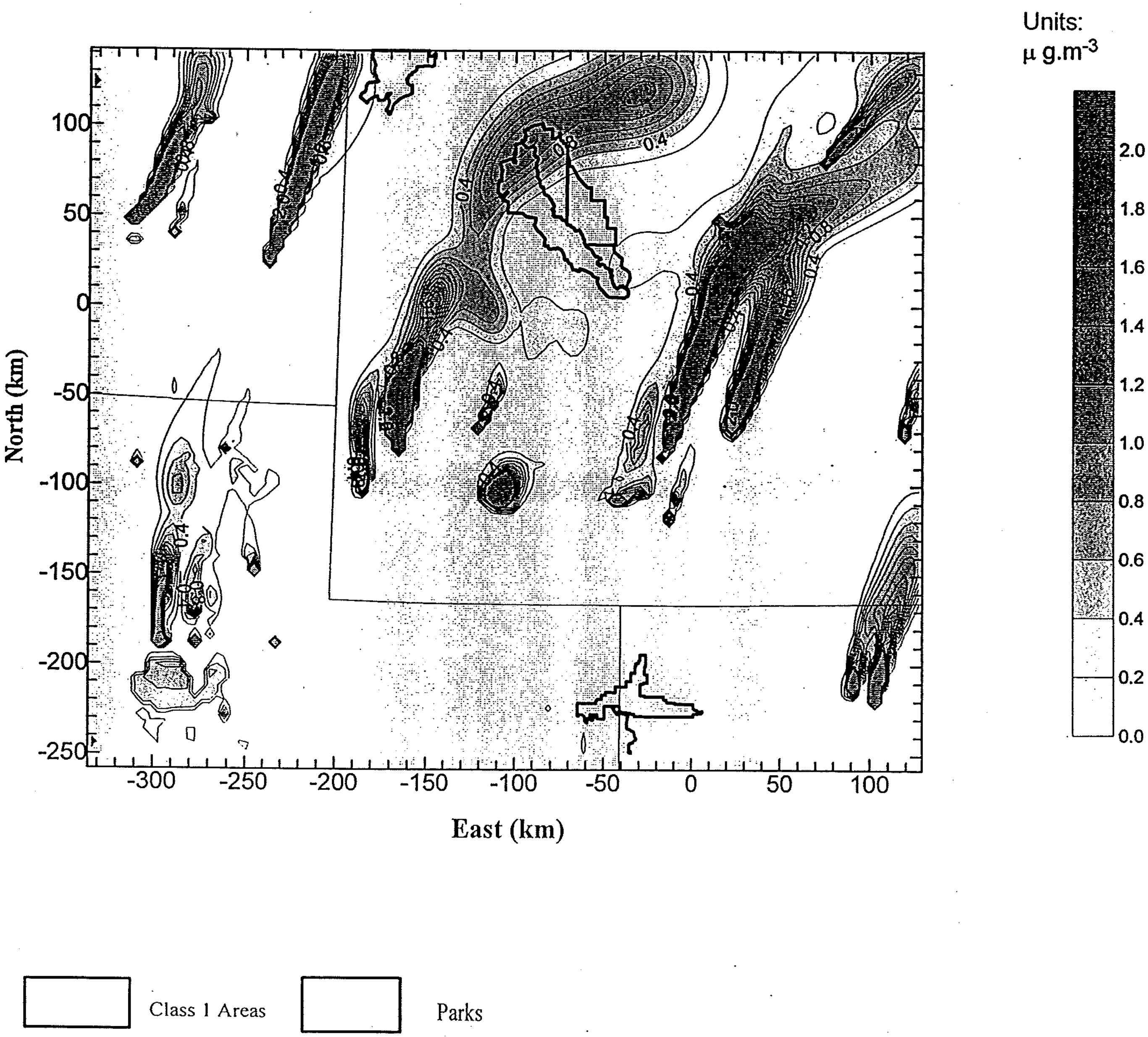
SO2 CONCENTRATION IN SWWYTAF AREA

16 hr July 12, 1995



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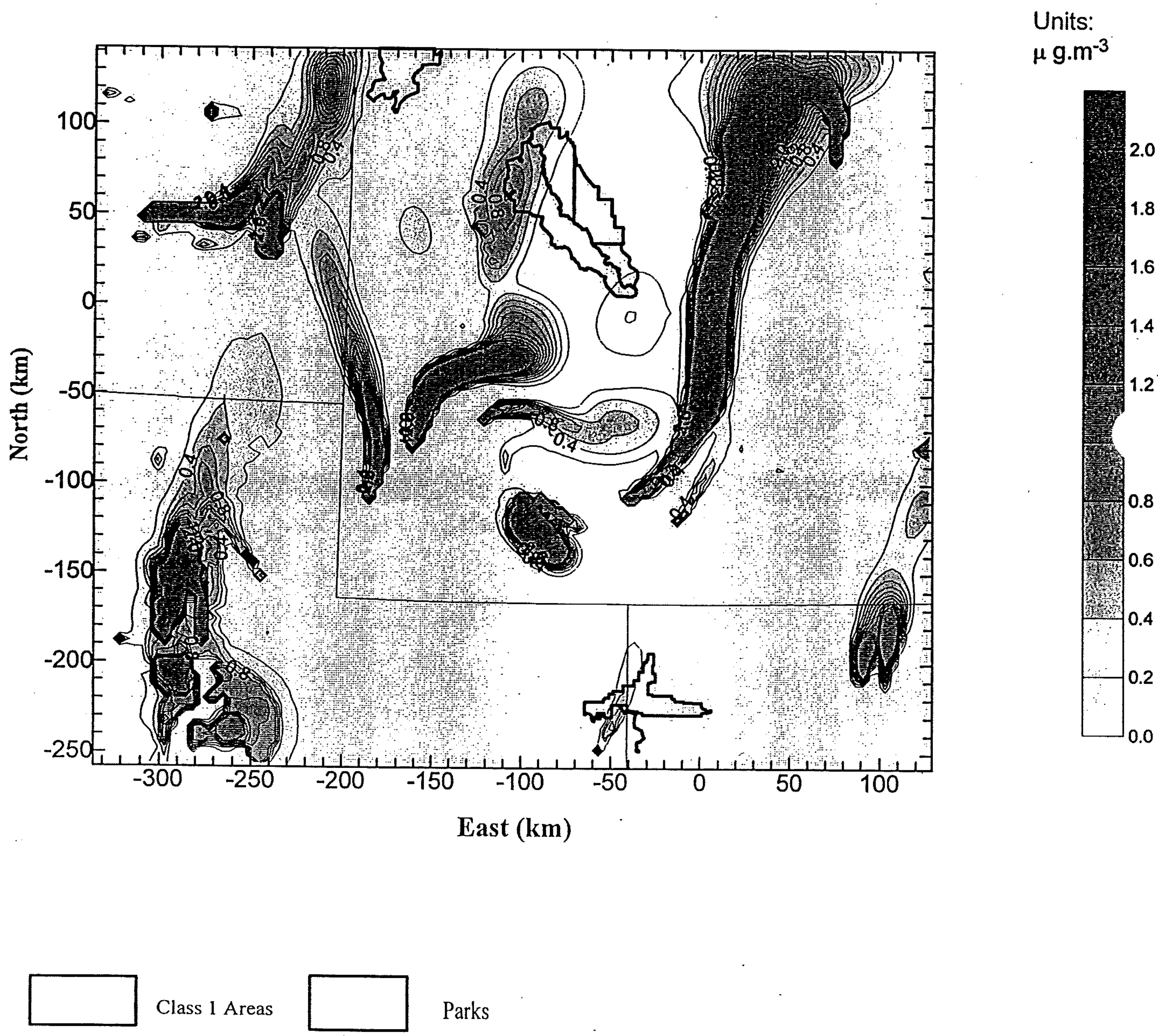
SO2 CONCENTRATION IN SWWYTAF AREA

20 hr July 12, 1995



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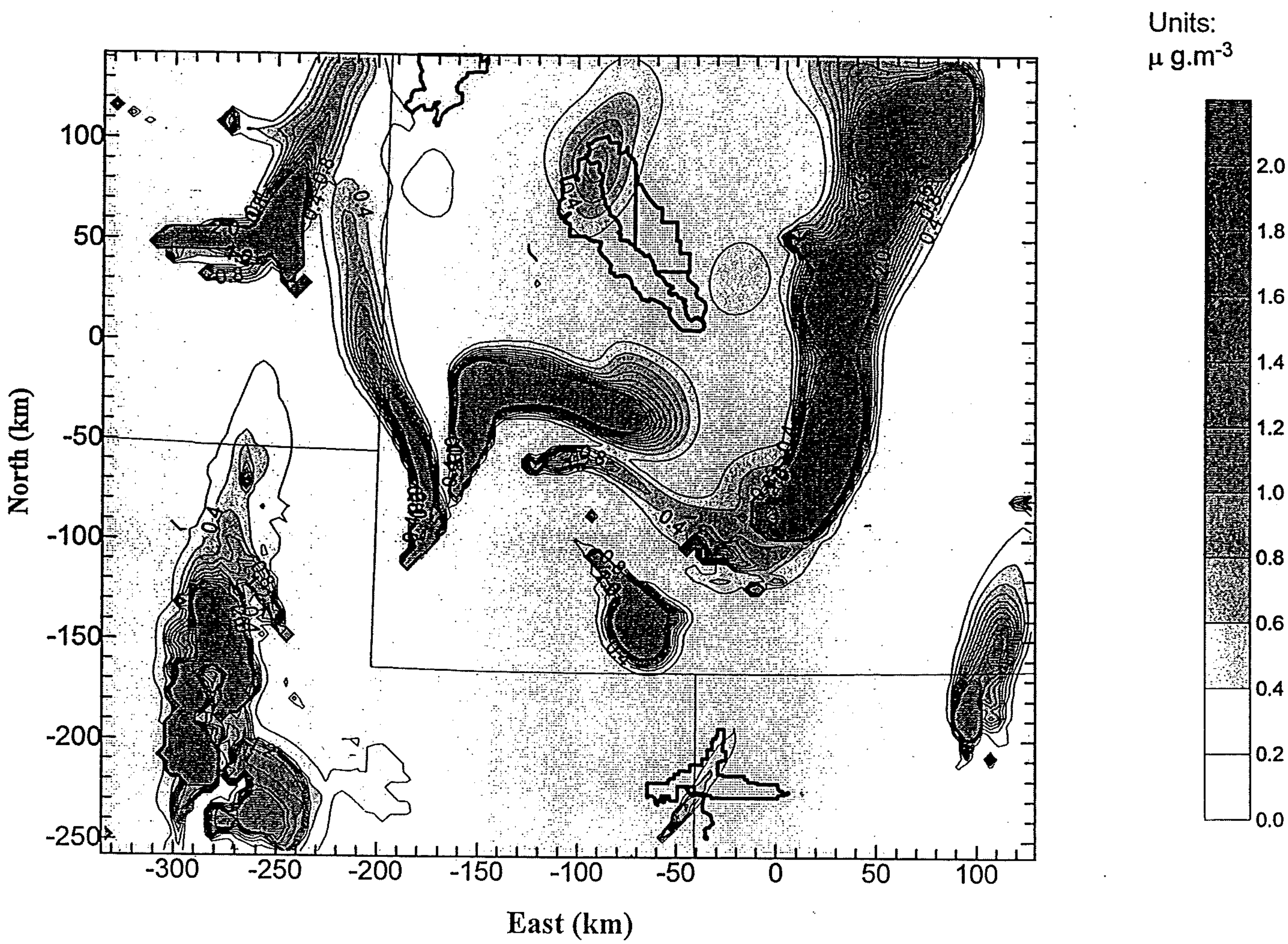
SO2 CONCENTRATION IN SWWYTAF AREA

21 hr July 12, 1995



Class 1 Areas

Parks

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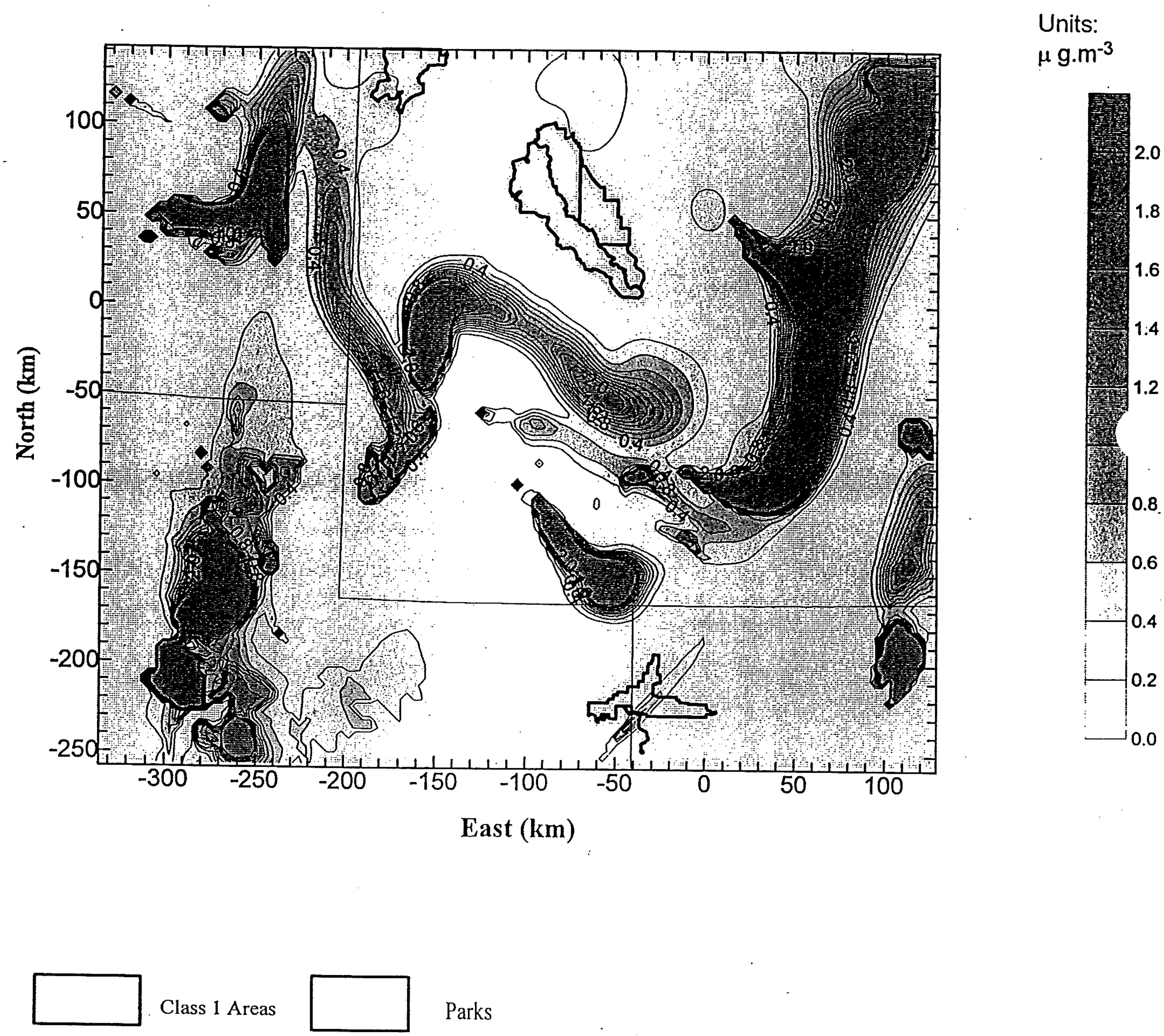
SO2 CONCENTRATION IN SWWYTAF AREA

22 hr July 12, 1995



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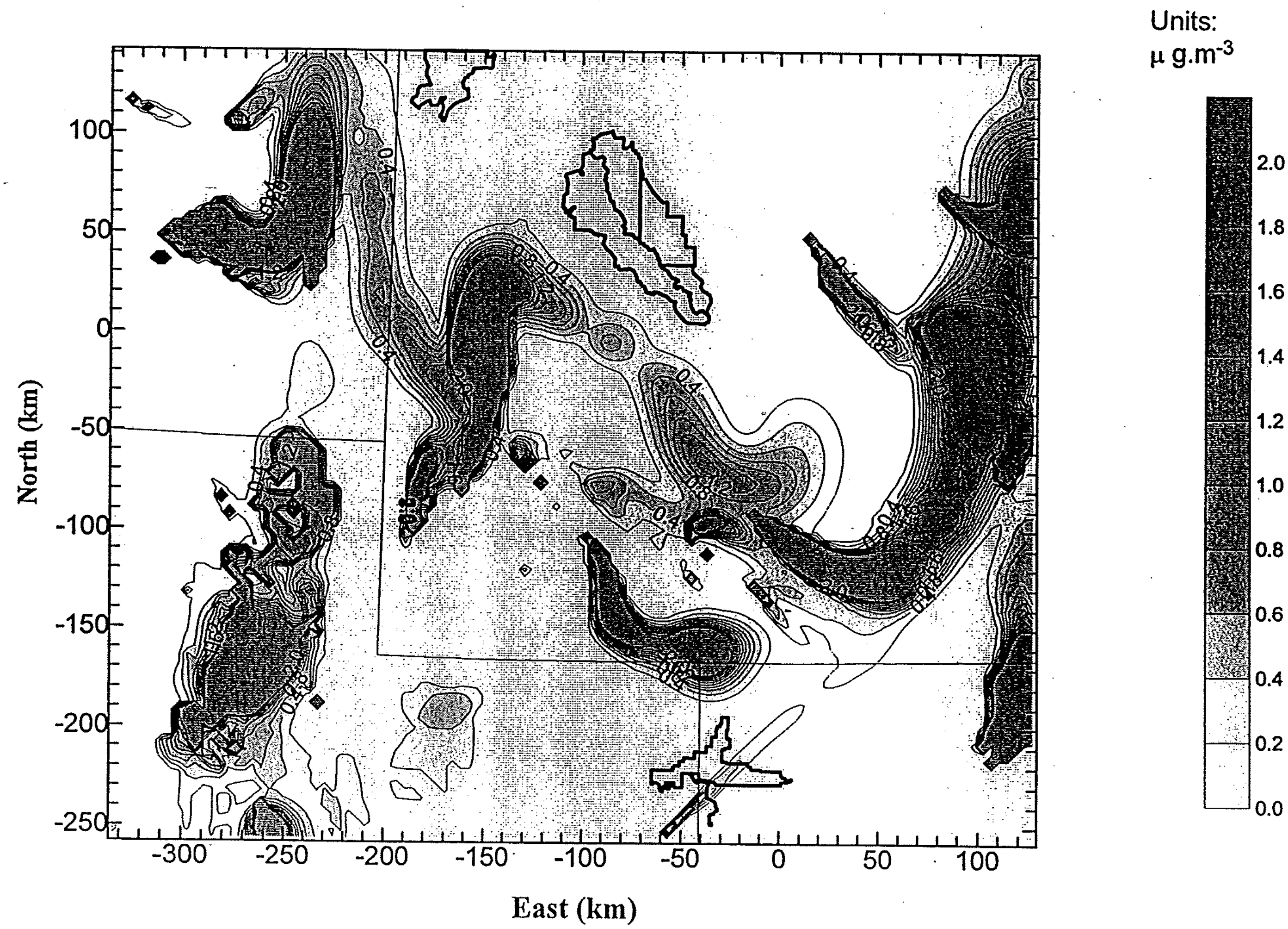
SOLVAY2016_1.4_001826

SO2 CONCENTRATION IN SWWYTAF AREA

23 hr July 12, 1995



Class 1 Areas

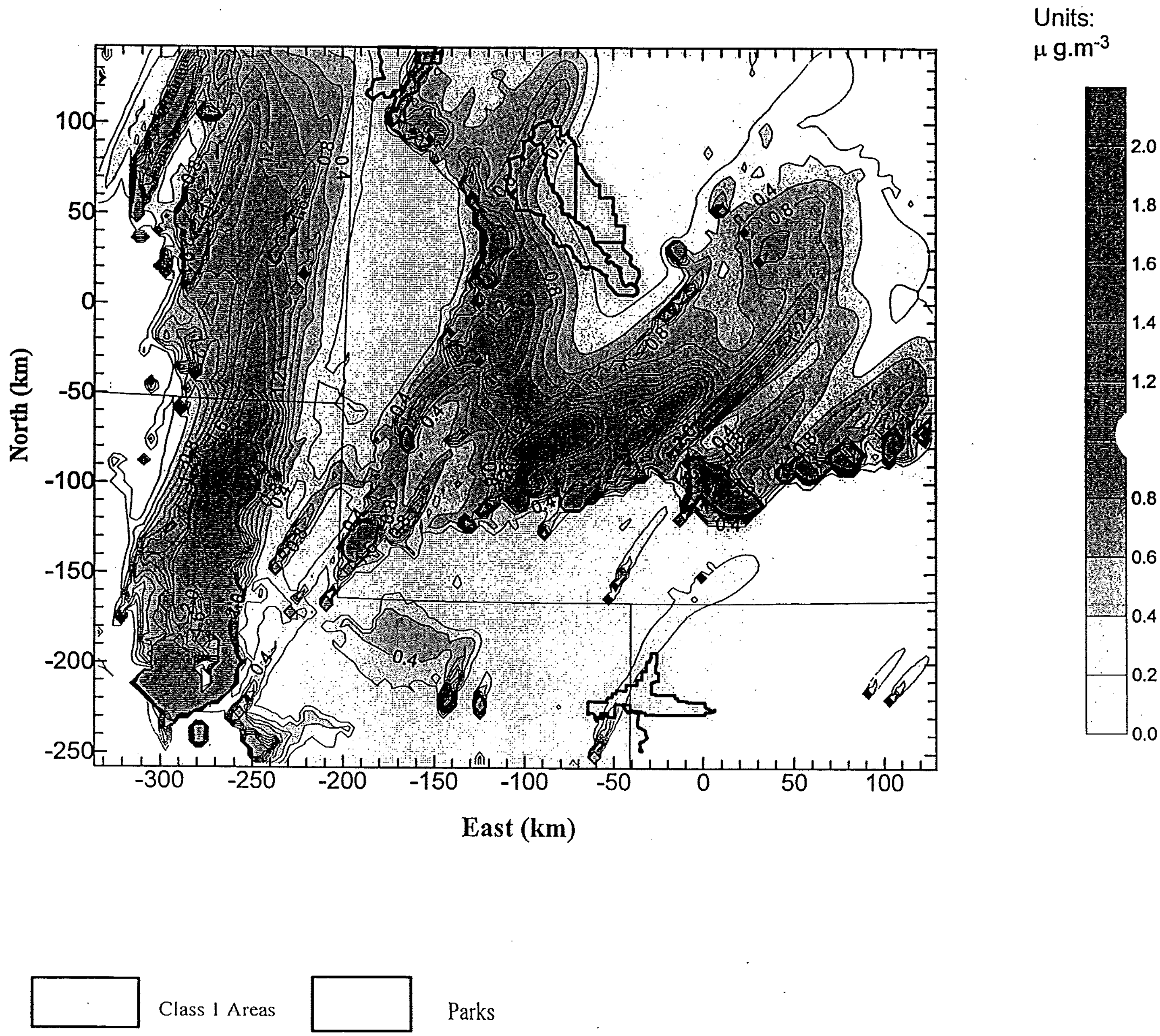
Parks

e:/projects/swwytaf/9901/1930123SO2.srf

SOLVAY2016_1.4_001827

NO2 CONCENTRATION IN SWWYTAF AREA

11 hr July 12, 1995



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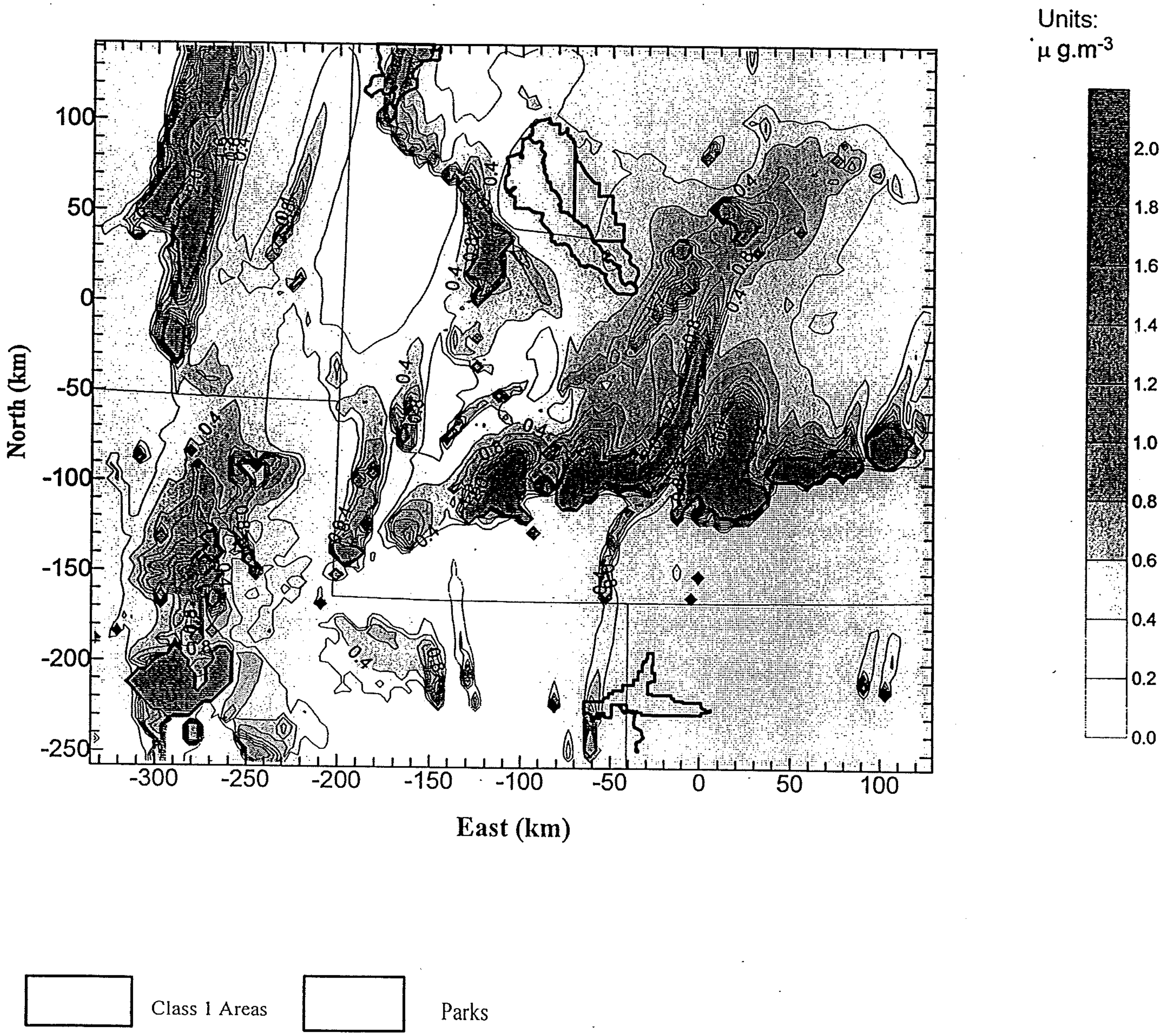
NO2 CONCENTRATION IN SWWYTAF AREA

17 hr July 12, 1995



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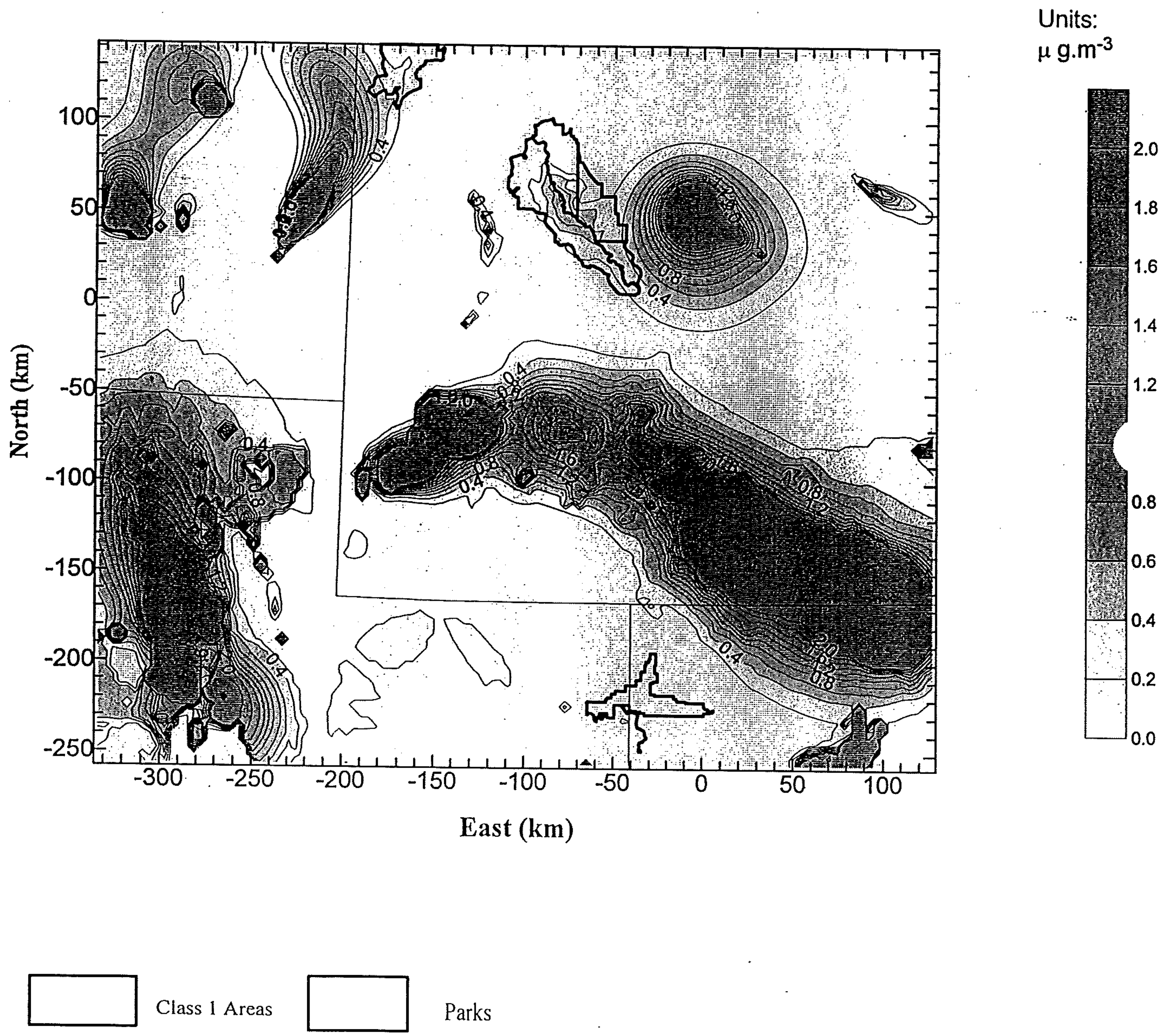
SO2 CONCENTRATION IN SWWYTAF AREA

18 hr December 26, 1995



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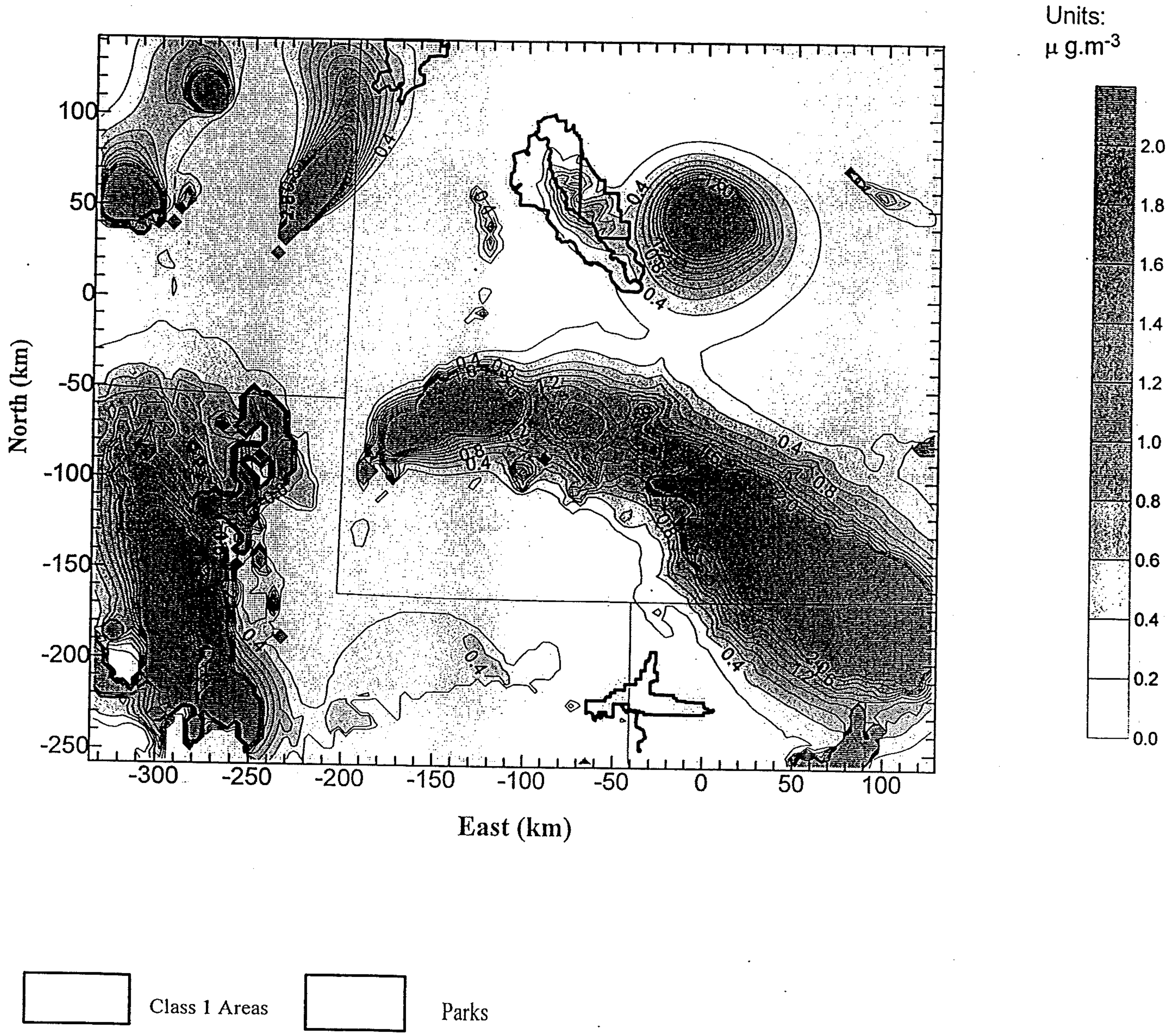
SO2 CONCENTRATION IN SWWYTAF AREA

19 hr December 26, 1995



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